

Producers Association of Carbon nanoTubes in Europe (PACTE)- **Code of Conduct for the Production and Use of Carbon Nanotubes**

- **Introduction**

Nanotechnology is widely seen as a key technology of the 21st century with a potential wide impact on many key sectors of the industry. Among the various nanomaterials being currently developed carbon nanotubes (CNTs) are often distinguished due to their great properties and the potential benefits they can deliver in many industrial applications (from materials engineering and electronics to medical devices and drug delivery systems). It is therefore essential for industry to ensure a sustainable development of these materials, particularly with respect to Health, Safety and Environment (HSE). With this in mind the main producers of CNTs in Europe have joined their efforts by working together within the CEFIC Sector Group PACTE. The goal is to develop CNTs by following the core principles and commitments of the chemical industry's Responsible Care® Global Charter. A result is this "Code of Conduct" that reflects the measures in place for the production and gives recommendations for the further processing and use of CNTs.

- **Scope**

The scope of this "Guide of Good Practice" is the production and use of carbon nanotubes. The term CNT describes a wide family of different products (e.g. single-wall, multi-wall) differing in a number of parameters, such as length, diameter, open or close-ended, purity, aspect ratio, agglomeration or morphology. These physico-chemical properties may have an influence on the intrinsic toxicity as well as on the exposure's potential (e.g. dustiness) of the specific CNT material.

Carbon nanotubes are chemical substances, and as such their production and use are covered by existing regulations on chemicals, and workers protection practices. Potential hazardous properties of carbon nanotubes are matter of ongoing research activities, therefore current good practice for the handling of carbon nanotubes is to minimize potential exposition of workers particularly via inhalative exposure route.

A regular review of the present recommendations is necessary in order to take into account the latest knowledge available.

- **Protection and Prevention Measures**

The following protection and prevention measures will be taken, listed in order of priority:

- ***Technical protective equipment***

Appropriate work processes, engineering controls and adequate equipment have to be used so as to avoid or minimize the release of carbon nanotubes. In cases where an activity cannot be conducted in a closed system, an appropriate local exhaust ventilation system is strongly recommended. To further reduce exposure to carbon nanotubes, work areas should be cleaned using suitable vacuum pickup (e.g. equipped with HEPA filter) or wet wiping methods, instead of dry sweeping or air hoses.

- ***Organizational Protection Measures***

Before working with carbon nanotubes, all workers must receive specific informations and instructions on the materials and processes, the risks involved, and training on the use of collective and personal protective equipments, control systems in place. In addition, work processes must always be carefully documented and approved before putting them into practice. Compliance with the instructions, particularly the compliance with required protective measures, must be routinely monitored.

- ***Personal Protection Measures***

In cases where exposure cannot be minimized by organizational protection measures and collective protective equipment, adequate personal protection measures must be used. Choice of respiratory protection must be risk based, however, in most cases, adequate protection from airborne carbon nanotubes can be obtained by using a filtering face piece respirator type FFP2 or FFP3. Current best practice is that dermal exposure should be minimized using suitable protective clothing and gloves. In addition, a high standard of personal hygiene after handling carbon nanotubes must be implemented.

- **Monitoring Workplace Exposure**

Workplace exposure monitoring is performed according to established occupational hygiene practices.

At the present time, there are no accepted occupational exposure limits for airborne carbon nanotubes and exposure should be maintained at background levels. As natural and incidental carbon nanoparticles are ubiquitous (e.g. combustion engine exhaust), measurements should be performed before production or use of carbon nanotubes in order to obtain background data. Measurements made during production or use can then be specifically evaluated to determine any changes in airborne levels and the appropriateness of the level of controls applied.

One has to take into consideration that measurement methods currently under development are not standardized so that comparing data across methods is subject to interpretation. PACTE members are significantly involved in safety research and standardization projects, such as TRACER, Nanosafe II and Nanotoxic, which focus on carbon nanotubes characterization and development of measuring methods for exposure assessments.

- **Worker Health Surveillance**

By carefully assessing the exposure risks and applying current best practice control measures, worker health risks should be adequately controlled. As an added precaution all workers handling chemicals, including carbon nanotubes, are subject to routine health surveillance to ensure that any work related change in health status is quickly determined and steps taken to identify and address the causes.

The frequency and extend of these examinations will be defined by a risk assessment for the workplace.

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